OIPE JC:43
MAR 10 2005
PATENT & TRADEMARK OFFICE

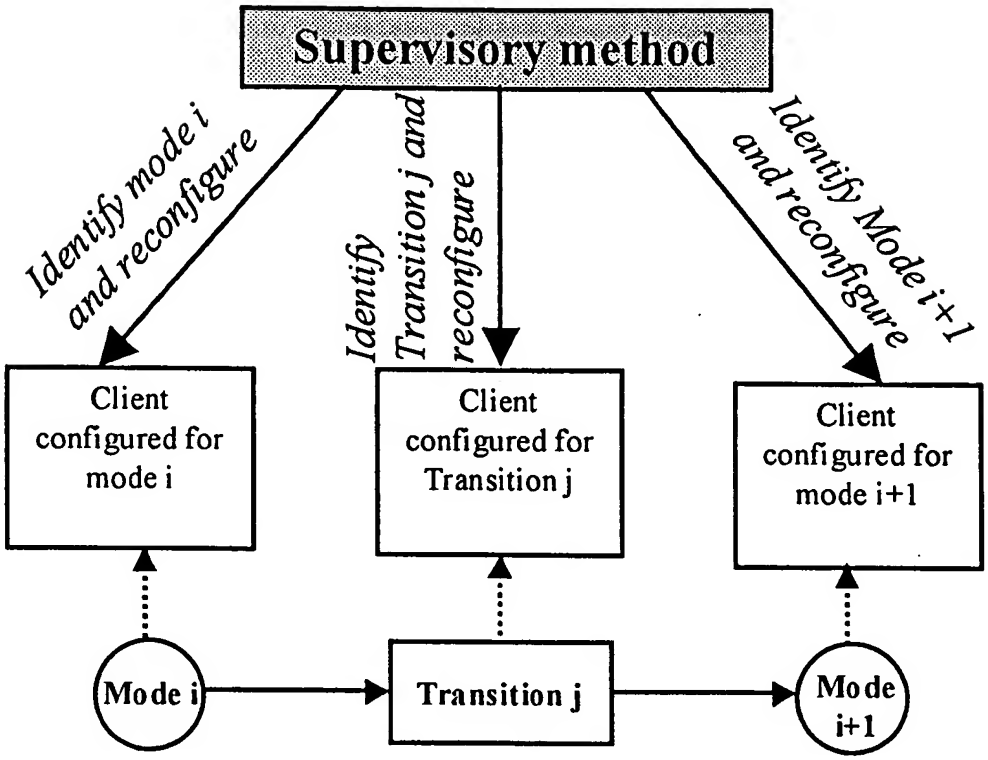


FIGURE 1

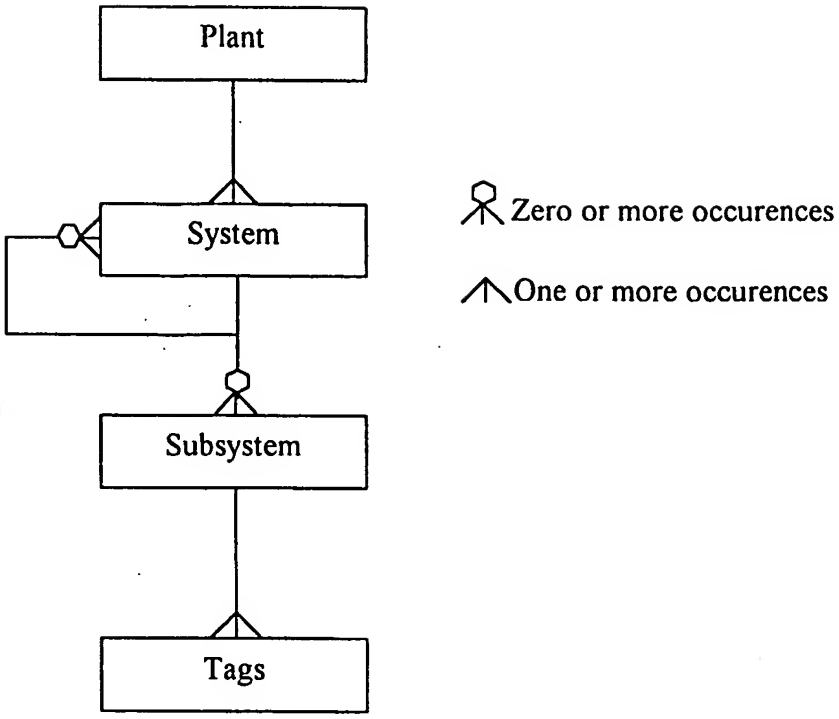

Plant
System
Subsystem
Tags
Zero or more occurences
One or more occurences

FIGURE 2

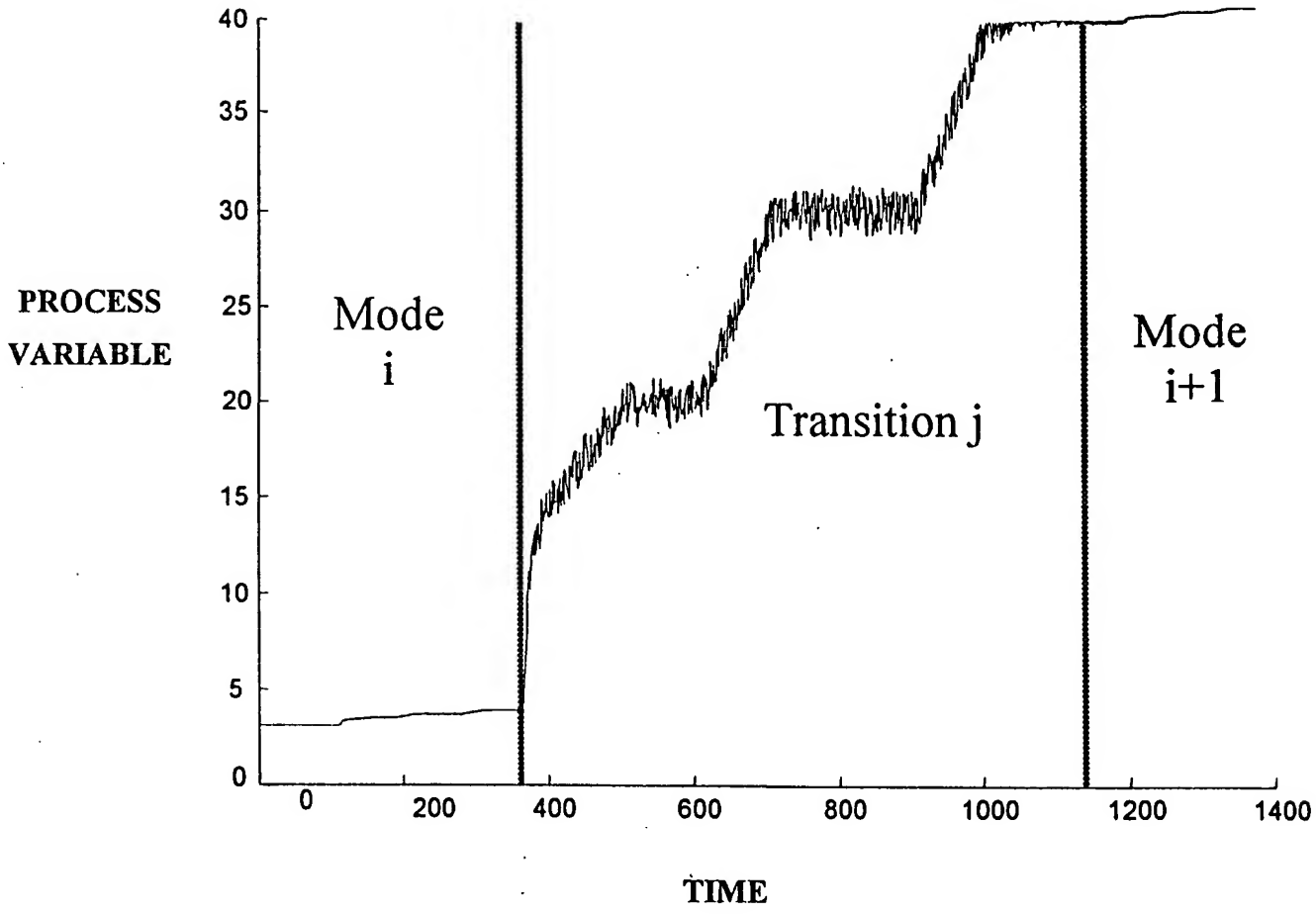

PROCESS VARIABLE
40
35
30
25
20
15
10
5
0
Mode i
Transition j
Mode i+1
0
200
400
600
800
1000
1200
1400
TIME

FIGURE 3

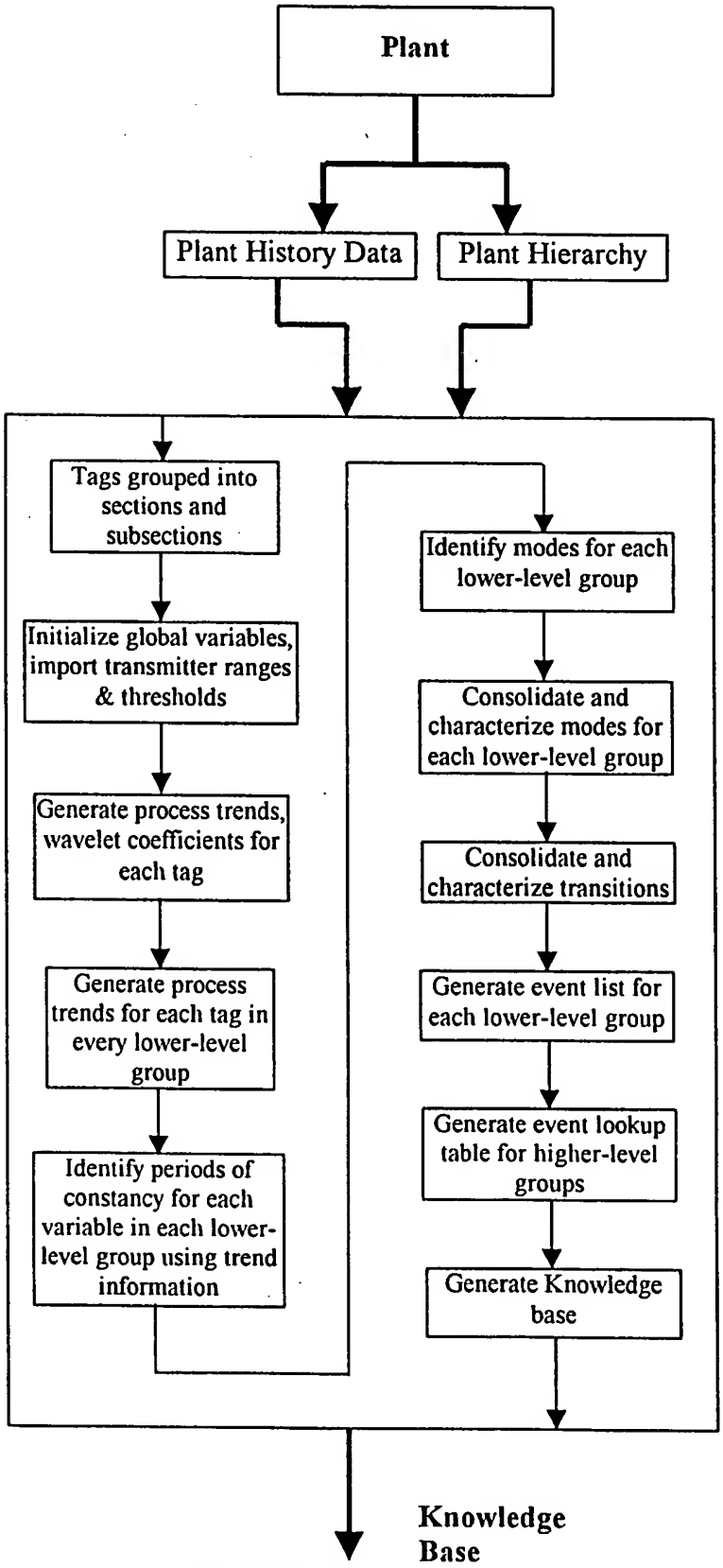

Plant
Plant History Data
Plant Hierarchy
Tags grouped into sections and subsections
Initialize global variables, import transmitter ranges & thresholds
Generate process trends, wavelet coefficients for each tag
Generate process trends for each tag in every lower-level group
Identify periods of constancy for each variable in each lower-level group using trend information
Identify modes for each lower-level group
Consolidate and characterize modes for each lower-level group
Consolidate and characterize transitions
Generate event list for each lower-level group
Generate event lookup table for higher-level groups
Generate Knowledge base
Knowledge Base

FIGURE 4

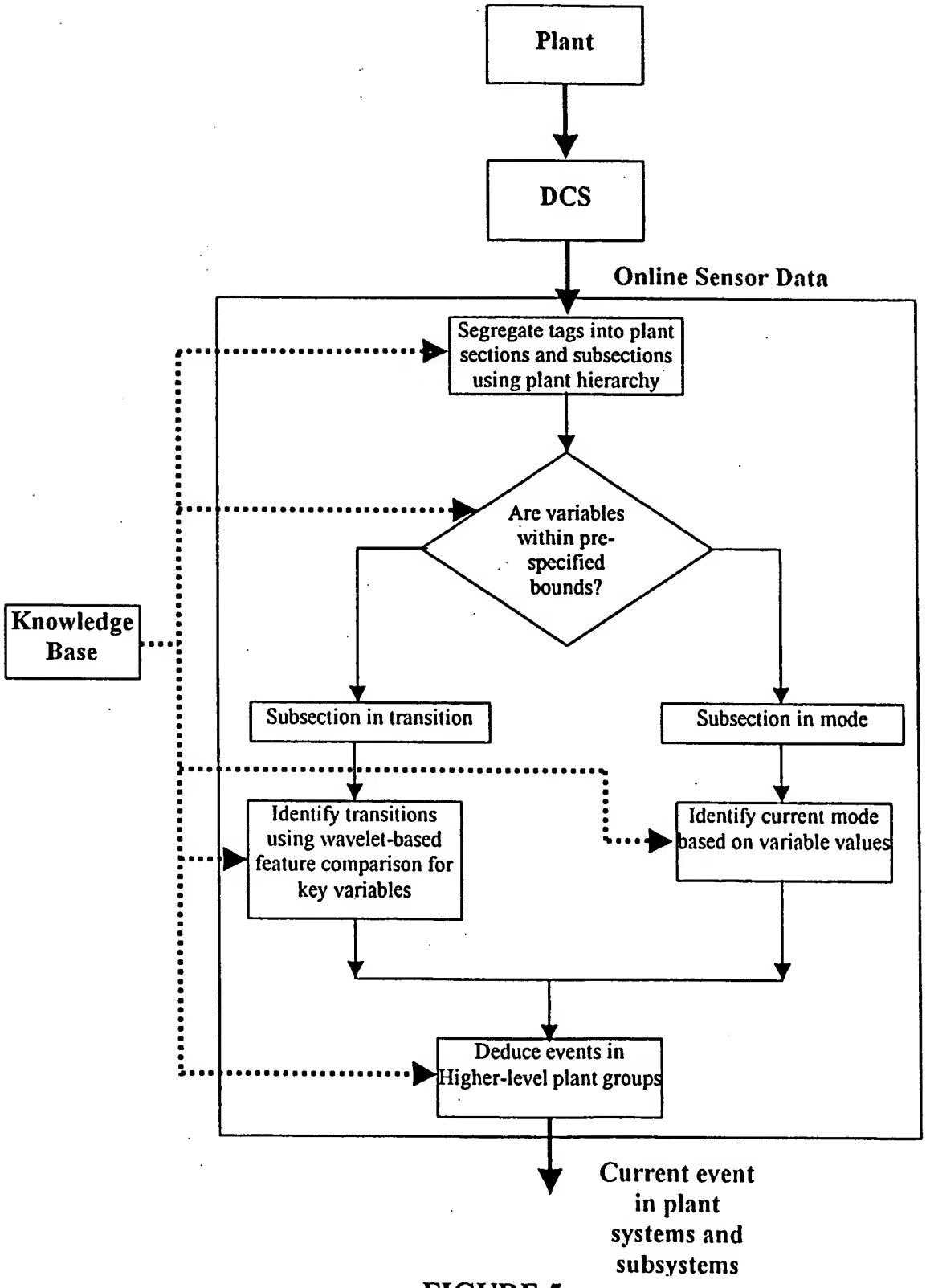

Plant
DCS
Online Sensor Data
Segregate tags into plant sections and subsections using plant hierarchy
Are variables within pre-specified bounds?
Knowledge Base
Subsection in transition
Subsection in mode
Identify transitions using wavelet-based feature comparison for key variables
Identify current mode based on variable values
Deduce events in Higher-level plant groups
Current event in plant systems and subsystems

FIGURE 5

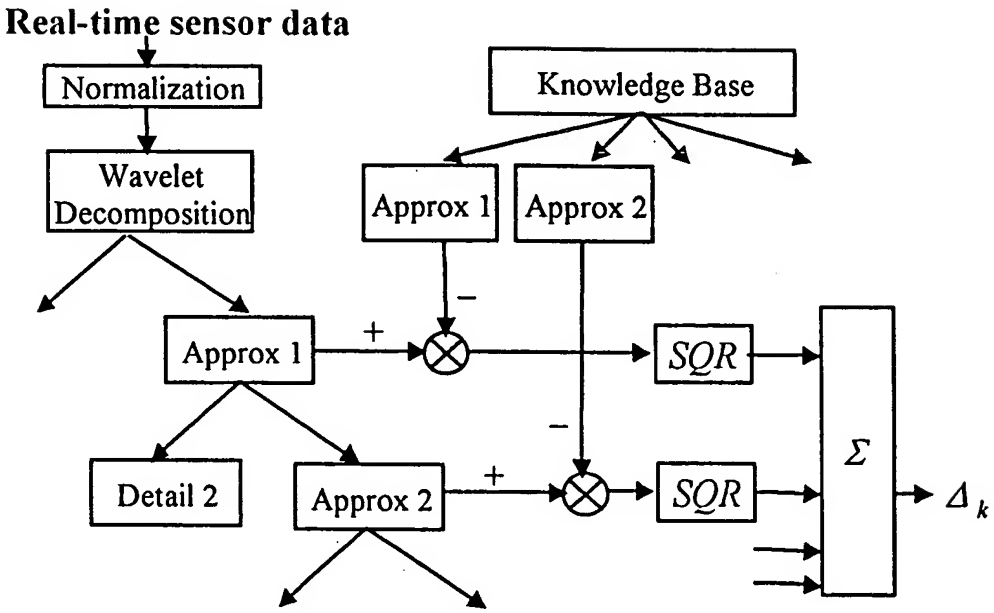

Real-time sensor data
Normalization
Wavelet Decomposition
Knowledge Base
Approx 1
Approx 2
Approx 1
Approx 2
Detail 2
+
−
+
−
SQR
SQR
Σ
Δ_k

FIGURE 6

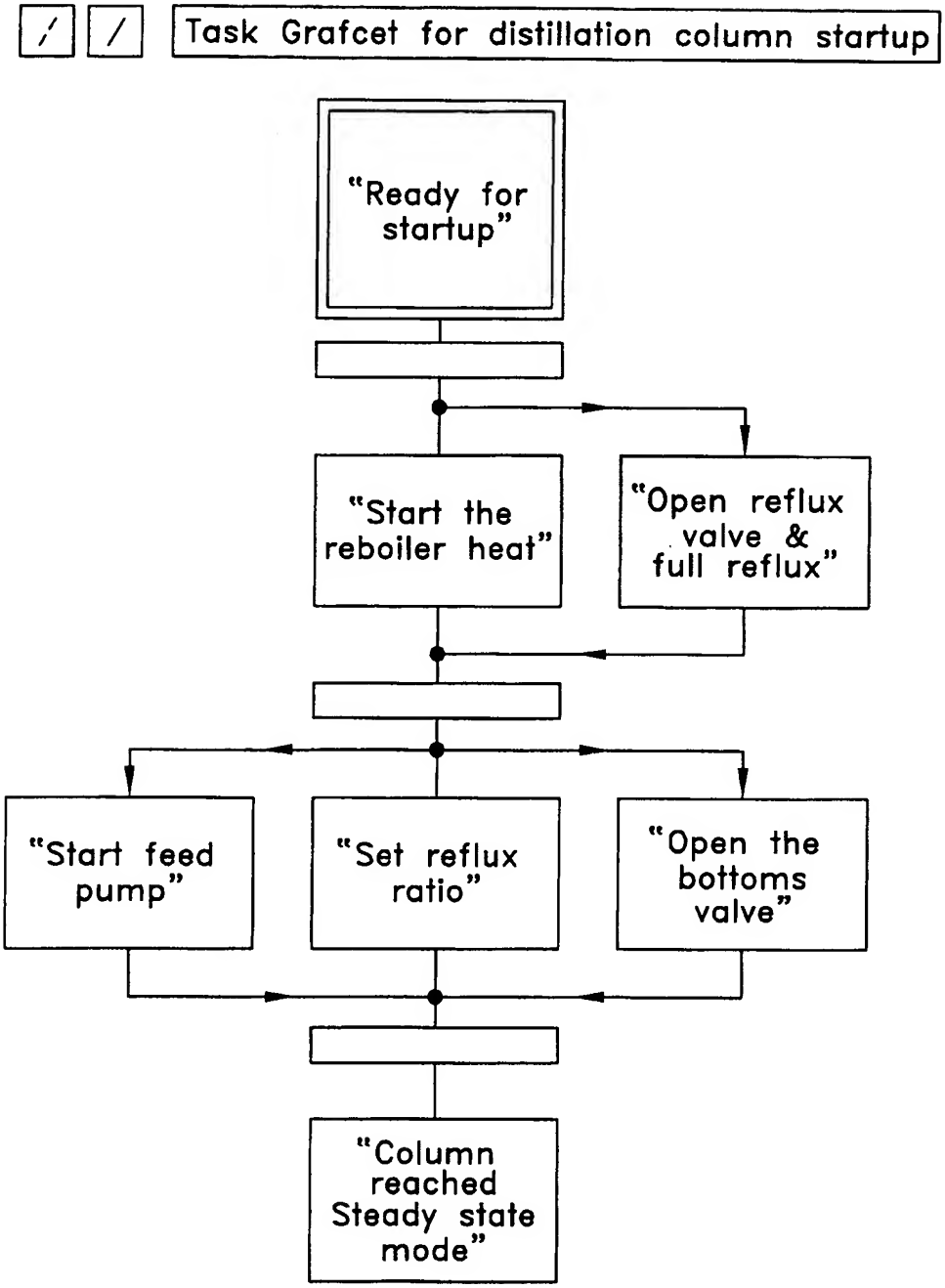
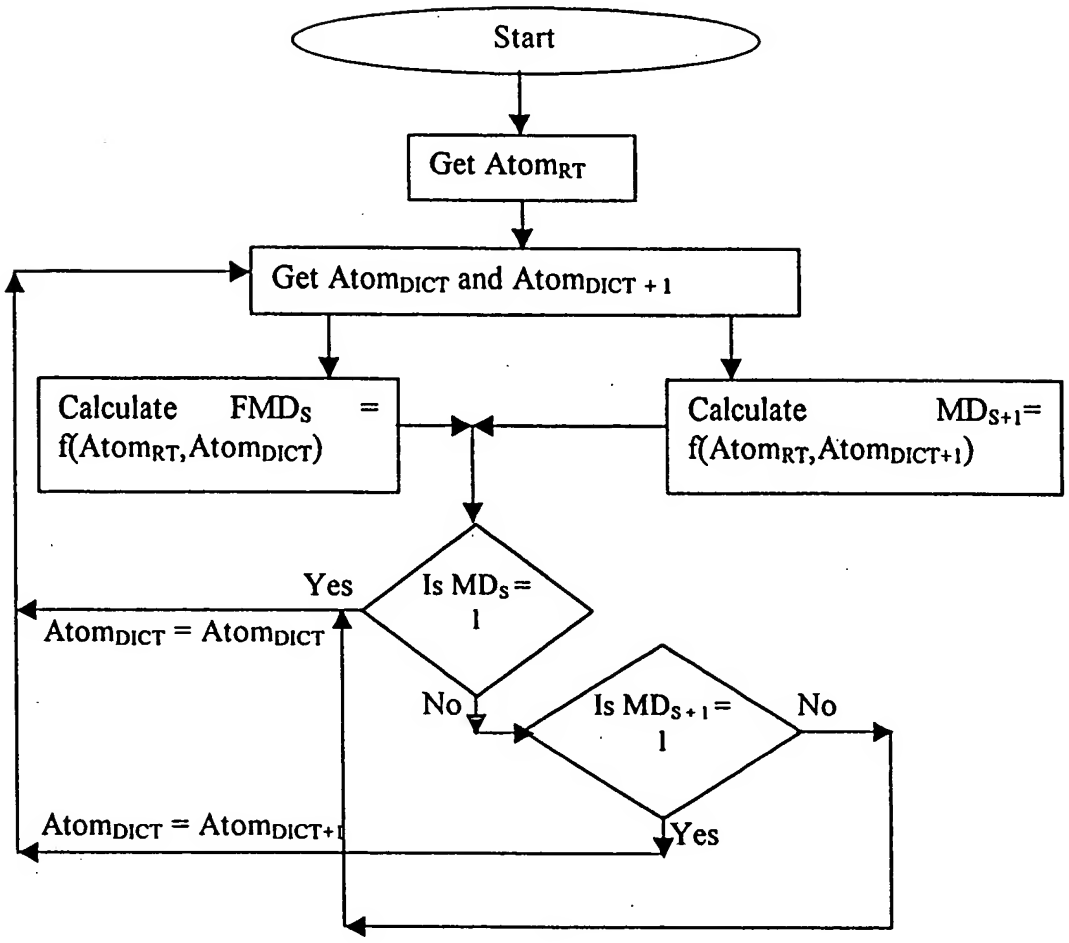

Task Grafcet for distillation column startup
"Ready for startup"
"Start the reboiler heat"
"Open reflux valve & full reflux"
"Start feed pump"
"Set reflux ratio"
"Open the bottoms valve"
"Column reached Steady state mode"

FIG. 7



LEGEND
MD- Matching-degree
SUBSCRIPT
S-shape
T-Time
M-magnitude
RT-Real time

FIGURE 8

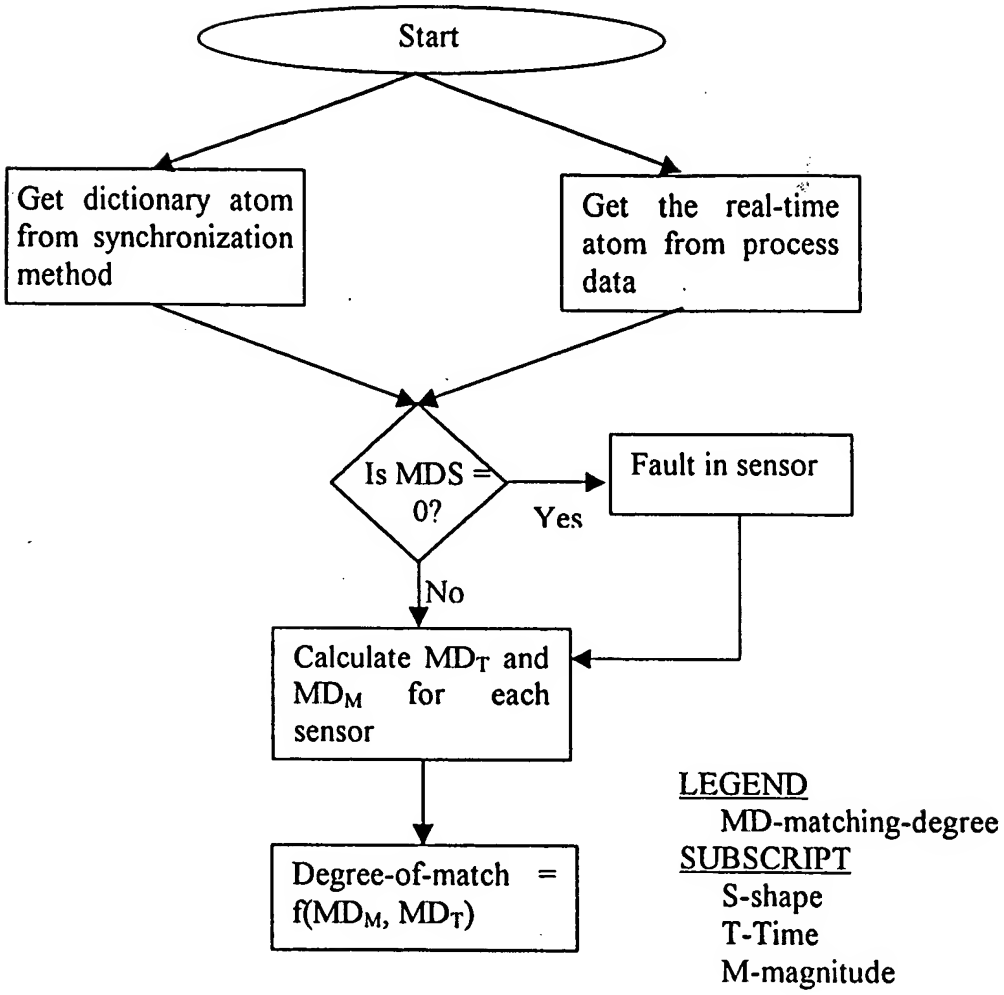

Start
Get dictionary atom from synchronization method
Get the real-time atom from process data
Is MDS = 0?
Yes
Fault in sensor
No
Calculate MD_T and MD_M for each sensor
Degree-of-match = $f(MD_M, MD_T)$
LEGEND
MD-matching-degree
SUBSCRIPT
S-shape
T-Time
M-magnitude

FIGURE 9